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PAL Control of Theater Nuclear Weapons (U)

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incorporated in dispersed weapons can be made solely in terms of broad policy considerations as to the desired objective."

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1.3.1.2 PAL General Characteristics (U)

(U) In September 1962, the Secretary of Defense approved a set of DoD design guidelines for PAL systems. These guidelines, entitled "General Characteristics for Permissive Devices for Use With Nuclear Weapons," or revisions thereof have served since that time as standards in specifying PAL devices in the MC of new weapons systems. The original guidelines and the four revisions (1969, 1970, 1972, and 1980) are included in Appendix B.

(U) The statement of purpose in the first edition of the General Characteristics of PAL defines:

> (U) "an arming control device for use with designated nuclear weapons which is intended to provide some additional physical means for preventing unauthorized use of nuclear weapons."[18]

(U) A number of specific design requirements are included. Most of these relate to specific operational features of the PAL system or to issues of compatibility with the rest of the weapons system. For instance, the PAL system

- (U) must not degrade weapon safety or reliability
- (U) must he compatible with weapon operational concepts as stated in the STS
- (U) must not significantly lengthen the reaction time for the weapon system

(U) These requirements are restated in all subsequent versions of the General Characteristics. However, as suggested in the Weisner memo, the objective of this system and its reason for existence is based on its ability to protect the weapon against unauthorized use by a potential adversary. Of the twelve specific design requirements stated in the original document, only one relates to the performance of PAL against an adversary.

[redacted]

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(U) Thus, the objective in terms of an adversary is not specified. However, some bounds are placed on the adversary's capabilities. The *function* of PAL is stated in terms of delay following unauthorized access to a weapon.

(U) In the 1969 edition, the stated purpose is

(U) "To provide general characteristics for permissive action links incorporated in weapons systems to prevent unauthorized nuclear detonation."[19]

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(U) In 1972, a new edition was prepared to include all existing PAL technology. While the statement of purpose remained essentially the same as in the 1969 edition, PALs are defined as

> (U) "devices and subsystems designed to reduce the possibility of obtaining a nuclear detonation from a nuclear warhead without the use (insertion) of a controlled numerical code, thus reducing the probability of an unauthorized nuclear detonation."[20]

DOE b(3)

2.1.1 PAL Devices (U)

(U) Table 1 shows current and planned weapons by PAL device type. These devices are discussed below.

Table 1. Current PAL-Equipped Weapons (U)

Combination Locks	CAT A	CAT B	CAT D	CAT F
W31	W50	B28-RE	B28-0,-1	B61-3,-4
W33		B43-2	B61-2,-5	W84
W45-3		B57-2	(B61-6,-7,-8)	W85
W48		B61-0	W70-1,-2,-3	
W54			W79	
			(W80-0)	
			W80-1	
			(W81)	
			(W82)	
			B83	

Note: ( ) indicates weapon in development

2.1.1.1 Combination Locks (U)

(U) Most weapons—bombs delivered by aircraft, missiles, and shells—experience a unique environment during deployment, e.g., spin, acceleration, pressure change. To provide the desired preflight handling safety, a family of ESDs evolved which close critical electrical arming lines only after the weapon experiences the desired environmental signature. In the case of ADMs, manually set in place and fired by either command or timer, there was no launch, drop, or fire environment which could be sensed by an ESD. Installation of 3-digit combination locks provided an additional safety step in the prefiring sequence (Figure 2). The 3-digit locks were redesigned by the AEC to provide 5 digits to be compatible with a 4-digit split-knowledge code management system. The Army also developed combination locks for use on several weapon systems. About half of the European stockpile is still equipped with combination locks. They are used on the W31 Nike Hercules, W45 MADM, W54 SADM, M422 (W33/8-in. AFAP) and M454 (W48/155-mm AFAP).

(U) The M422 uses an Army lock. The M83 atomic weapon locking device screws into the projectile's base; one part (the locking tube and desiccant assembly) occupies the volume into which the breech-lock-fuze assembly must be installed before firing. The M454 uses an Army lock. The M76 atomic weapon locking device screws onto the projectile's nose, replacing the projectile's fuze (Figure 3). The W31 warhead for the Nike Hercules missile uses an Army lock. The M77 atomic weapon locking device fits onto the safing plug of the Adaption Kit (AK) (Figures 4 and 5). The W31 warhead for the Honest John missile uses an Army lock. The M81 atomic weapon locking device fits onto the safing plug of the AK (Figures 6 and 7).

(U) The W45-3 warhead for the MADM uses an AEC lock. The MC1885 padlock is installed on the warhead's J1 connector and prevents input of electrical signals to warhead circuits (Figure 8). The B54 warhead for the SADM also uses an AEC lock. The MC1948 lock-secured cover includes an MC1827 padlock (Figure 9). The cover denies unauthorized access to the arming and fuzing components.

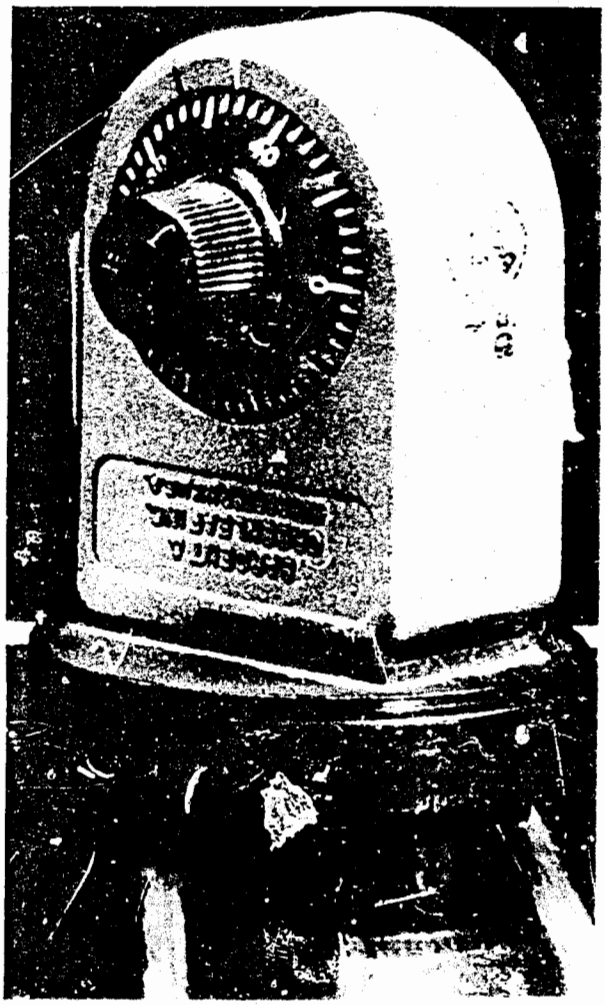


Figure 2. Combination Lock (U)

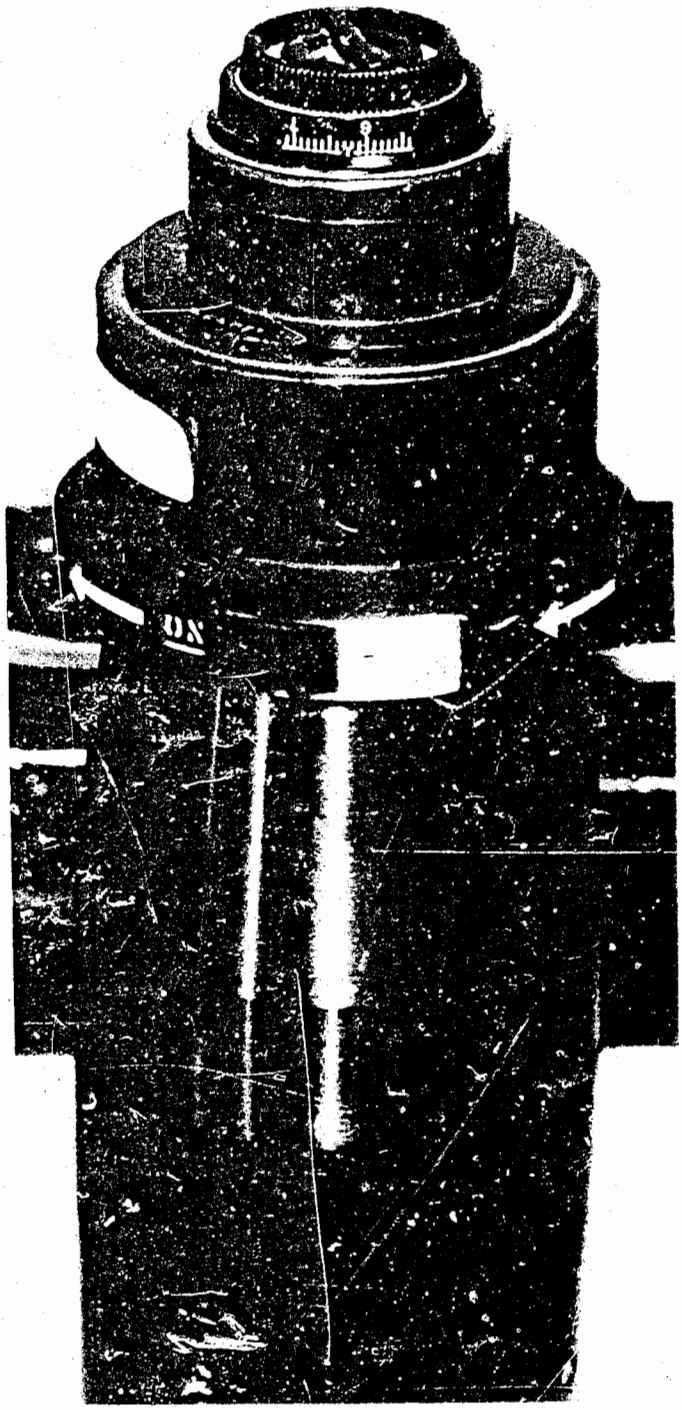


Figure 3. M70 Atomic Weapon Locking Device (L

Figure 4. M77 Atomic Weapon Locking Device (U)

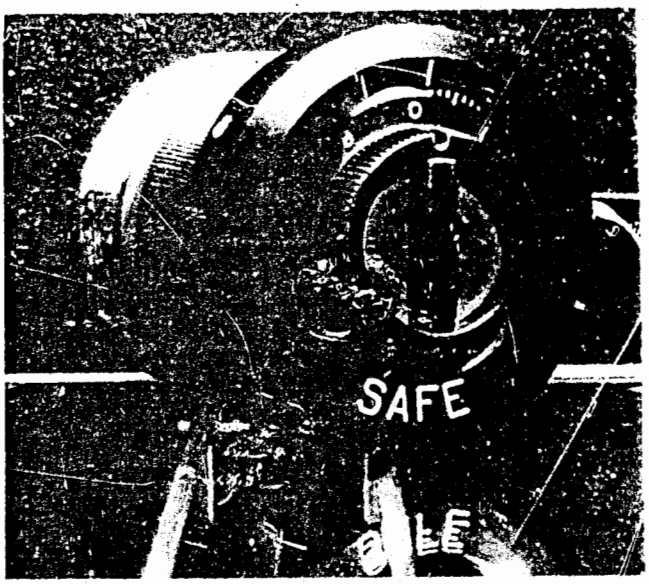
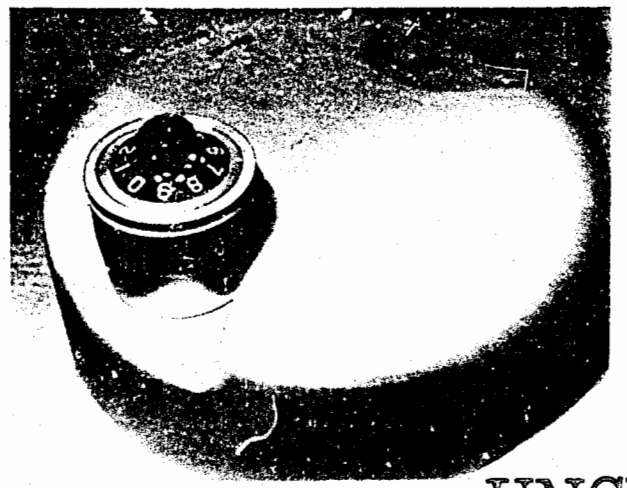


Figure 7. Mod Atomic Weapon Locking Device (U)

a



b

Figure 8. MC1552 Padlock (U)

(U) As originally fielded, the CAT B PAL system (Figure 11) included two electromechanical coded switches (MC1707s) in each weapon, two ground controllers (T1508 Decoder and T1509 Recoder), two controller testers (T1520 and T1521 for the Decoder and Recoder, respectively), three aircraft controllers (DCU117/A and DCU121/A, combined AMAC and PAL, and the DCU116/A PAL only), and a power source (T436 Battery). CAT B was installed only in bombs which have Air Force and Navy applications (primarily Air Force).

(U) The subsequent fielding of CAT D and F PAL has resulted in requirements for back-compatibility of CAT B with newer control equipment developed for CAT D and F. Today, CAT B PAL can be operated by the T1535 Ground Decoder; the T1536, T1555, and T1563 Recoders; the T1539 Verifier; and the DCU192, 196, 201, 218, 238, and 239, as well as those controllers listed earlier.

(U) The MC1707 (Figure 12) occupies a retangular volume of ~18 cu in., weighs ~ 2.2 lbs, and takes ~30 s to operate. It is used today in the B28-RE, B43-2, B57-2, and B61-0 bombs. Several improvements were made in the MC1707 design to overcome problems with the CAT A PAL system. The CAT B system requires 5 wires to recode, control, and monitor a weapon instead of the 14 required by CAT A. In addition, to minimize the impact on aircraft wiring, only three wires are required to control any number of switches operating in parallel, plus one wire per weapon to monitor the weapon's lock/unlock status.

(U) The CAT B system provides recode and code check capability for the stored codes without transferring the output contacts from the locked to the unlocked condition, or vice versa. Also, CAT B requires use of the stored code for a lock operation. This avoids possible accidental relock upon insertion of a wrong code after unlock. Finally, the recoders provide automated sequences of old code insertion, new code insertion, and code check operations.

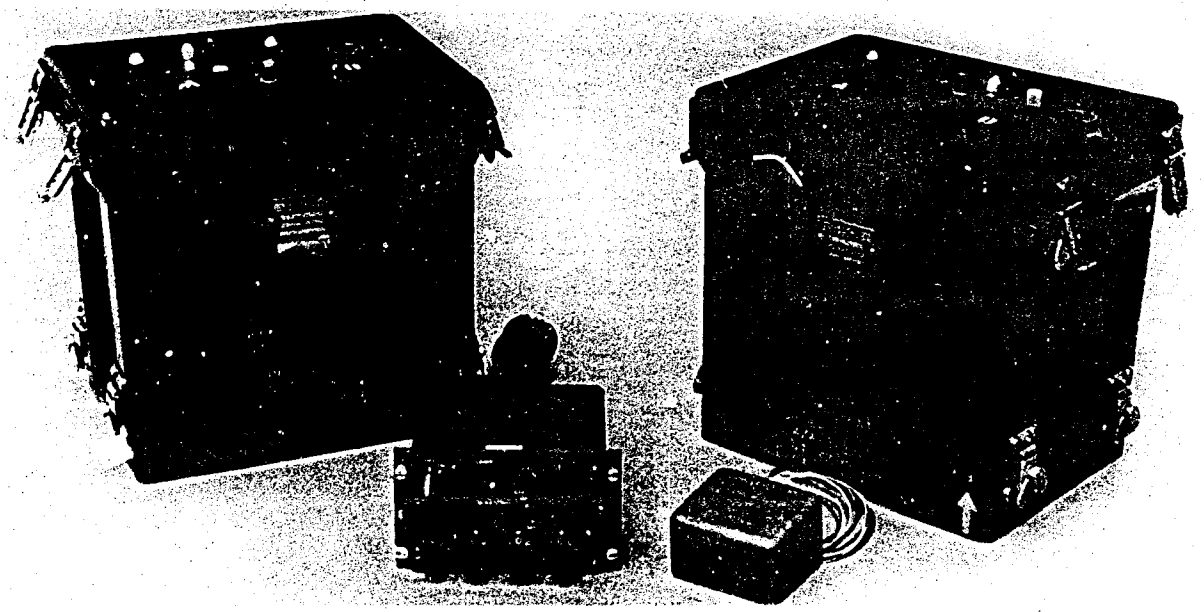


Figure 11. CAT B PAL System (U)

Figure 12. MC1707 (U)

2.1.1.4 Multiple-Code Coded Switch (U)

(C) A desire for selective unlocking through the use of multiple codes led to the concept of a multiple-code coded switch (MCCS). In May 1971, a requirement to incorporate an MCCS into the W74 was approved as Amendment 3 to the 155 mm Howitzer Projectile Military Characteristics. Miniaturization was essential because of the small volumes of the newer systems (W74 155-mm and W75 8-in. projectiles).

The MCCS design combined some new PAL-associated features with existing and still-required characteristics. They were:

- No power required for memory storage
- Compatible with aircraft cockpit control
- Knowledge of old code required for recode

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(C) The MCCS was developed as two separate items, the MC2764, ~17 cu in. (Figure 13), and the MC2907, ~1.5 cu in. (Figure 14). Both devices provide similar capabilities and are compatible with the same control equipment. MC2764 was developed on an accelerated basis to be available on an early timescale and is used in the W70-1 Lance and B61-2 CAT D applications. MC2907, with more difficult packaging concepts but employing basically the same hybrid microcircuit technology, was developed on longer timescales and is presently used or planned in the B28-0, and -1, B61-5, -6, -7, and -8, W79, W80, W81, and B83 CAT D applications.

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2.1.1.5 Multiple Code Coded Security Switch (U)

(C) The MC3641 MCCSS, sometimes called GLCM Security Unit (GSU), is ~4.36 cu in. in volume and will be used with the GLCM to provide a 12-digit

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code capability (Figure 15). It will permit numerical assurance against bypass in accordance with DOD Directive 5200.16 in several scenarios associated with unauthorized launch.

DOE b(3) ID or serial number can be obtained upon query. Because the MCCSS is microprocessor-controlled and because of the different code length, a byte-oriented data format between the controllers and the MCCSS was chosen. The MCCSS will require new control equipment for recode and control. The T1563 Automated PAL Controller is being fielded on a timescale compatible with the GLCM for recode and APS maintenance control.

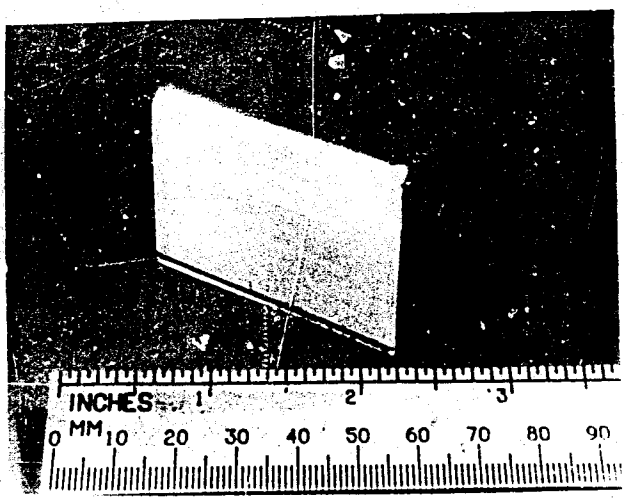

Figure 15. MC3641 (U)

Figure 13. MC2764 (U)

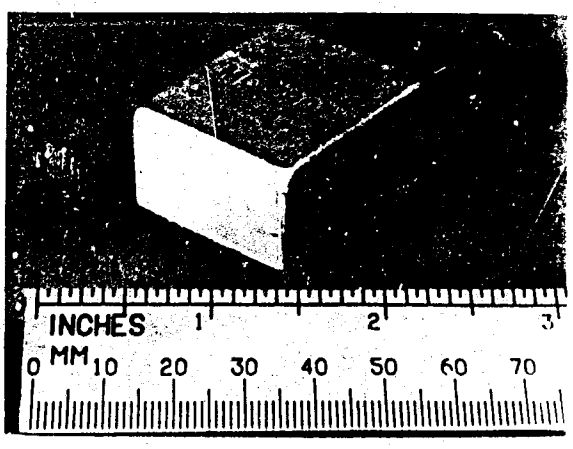

Figure 14. MC2907 (U)

2.1.1.6 Active Protection Systems (U)

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2.1.2 Control Equipment (U)

(U) PAL control equipment has become very diverse and, in some cases, quite specialized. In most cases, control equipment was designed and developed by the DOE with DOE funds in response to DOD needs. Production has usually been managed by DOE and funded by DOD. There have been a few recent examples of specialized application (PII and GLCM) for which DOE specifications were provided, and design, development, and production were funded and managed by DOD. The categories of PAL control equipment are:

Recoders (Recode and Code Check)
Verifiers (Code Check)
Ground Decoders (Unlock and Lock Control)
Cockpit Decoders
Controller Testers

(U) The listing of Table 2 is believed to be complete. Newer controllers are back-compatible with earlier categories of PAL, except for CAT A. In most cases, older controllers have remained operational, particularly the decoders, because they are usually available and meet original operational requirements. Individual ground control items are discussed below.

Table 2. DOE-Supplied PAL Ground Controllers (U)

Item	Function	Quantity	FI U Date	PAL Category	Military Service
T1500A	Decoder	578	3/63	A	Army
T1501A	Recoder	57	3/63	A	Army
T1502	T1500/01 Tester	274	7/63	A	Army
T1508	Decoder	340	3/64	B,B′	AF/Navy
T1509	Recoder	39	3/64	B,B′	AF/Navy
T1520	T1508 Tester	442	4/64	B,B′	AF/Navy
T1521	T1509 Tester	39	4/64	B,B′	AF/Navy
T1526**	Recoder	17	8/73	C	Army
T1527**	Decoder	33	6/73	C	Army
T1533	Decoder	192	11/73	C,D,E,F	Army
T1534	Recoder	37	12/73	C,D,E,F	Army
T1535	Decoder	182	1/75	B,D,E,F	AF/Navy
T1536	Recoder	23	2/75	B.D,E,F	AF/Navy
T1539	Verifier	12	5/75	B,C,D,E,F	AF/Navy
T1547	CAT F Adapter	118		E,F	
T1549A	Controller Tester	147	6/75	B,D,E,F	AF/Navy
T1554	Decoder	308	1/81	D,E,F	Army/Navy
T1555	Recoder/ Verifier	40	4/79	B,D,E,F	All
T1563	Recoder/Controller	130*	10/83	B,D,E,F	All
T1565	T1563 HQ EQ	2*	7/84		All

* Estimates
** No Longer Used

2.1.2.1 T1500 Category A Decoder (U)

(U) The T1500 controller is used to unlock and lock the MC1541 coded switches (Figure 16). It drives the MC1541 motor to a position consistent with the code selected and set in the T1500, provides energy to open or close the output switches, and monitors the status of the MC1541. The T1500 weighs ~40 lbs with the T436 Power Supply attached. It controls two MC1541s simultaneously from the two independent channels and indicates when at least one of the MC1541 output switch sets closes.

2.1.2.2 T1501 Category A Recorder (U)

(U) The T1501 is similar to the T1500 decoder but has a code change capability (Figure 17). It selectively operates only one MC1541 coded switch at a time, first setting in the correct old code, then unlocking and preparing the switch for insertion of a new code. The new code is then set into the T1501 and the operation repeated, inserting the desired new code. An incorrect code must then be entered to relock the coded switch. This does not occur in an automated sequence but is done as separate operations for each of two coded switches in the weapon.

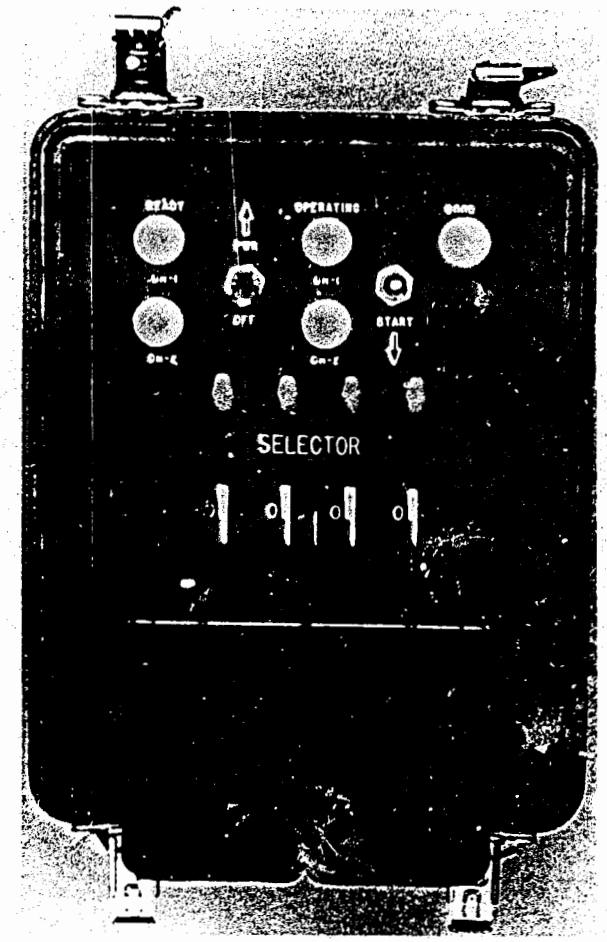

Figure 16. T1500 CAT A PAL Controller (U)

Figure 17. T1501 CAT A PAL Recoder (U)

2.1.2.10 T1536 Air Force/Navy Recoder for PAL Categories B, D, and F (U)

(U) The T1536 (Figure 26) is a controller used by the Air Force and Navy to recode and code-check the coded switch in a weapon; it can also be used to check the lock/unlock status of the weapon.

(U) A single-code or all-codes recode operation will always leave the weapon coded switch in the locked state. A code-check operation will not change the locked/unlocked status of the coded switch. The T1536 automatically recognizes a coded switch system as either single code (CAT B) or multiple code (CAT D/F) and furnishes the appropriate signals to the coded switch in a weapon. Power is supplied to the T1536 through a CT1478 cable from the T436B Power Supply. All of the necessary codes (one old and six new PAL codes) plus one new maintenance code are manually set into the T1536. After the codes are set, recoding or code-check is a single-cycle, semiautomatic operation.

2.1.2.11 T1539 Army/Air Force/Navy/ Code Verifier for PAL Categories B, C, D, and F (U)

(U) The T1539 is a controller used in the field by the Army, Air Force, and Navy to check code values in the coded switch in CAT B, B', C, D, and F PAL weapons; it may also be used to check the locked/unlocked status of the weapon. The T1539 recognizes a coded switch system as either single code (CAT B/B'/C) or multiple code (CAT D/F) and furnishes the appropriate address to the coded switch in the weapon. Power is supplied to the T1539 through a CT1478 cable from a T436B Power Supply.

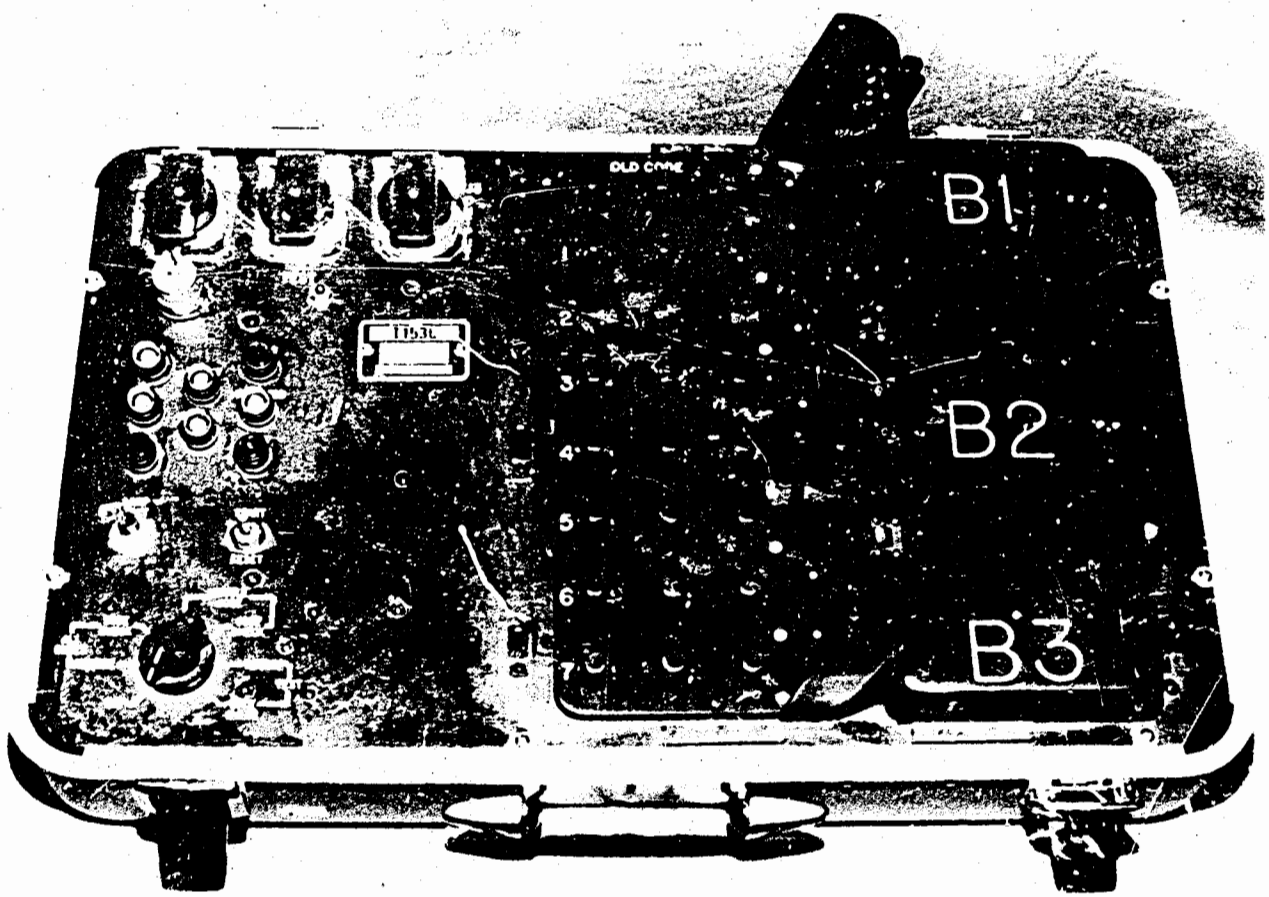

Figure 26. T1536 Air Force Recoder for CAT B, D, and F PALs (U)

2.1.2.12 T1547 Army/Air Force/Navy Adapter for Category F PAL (U)

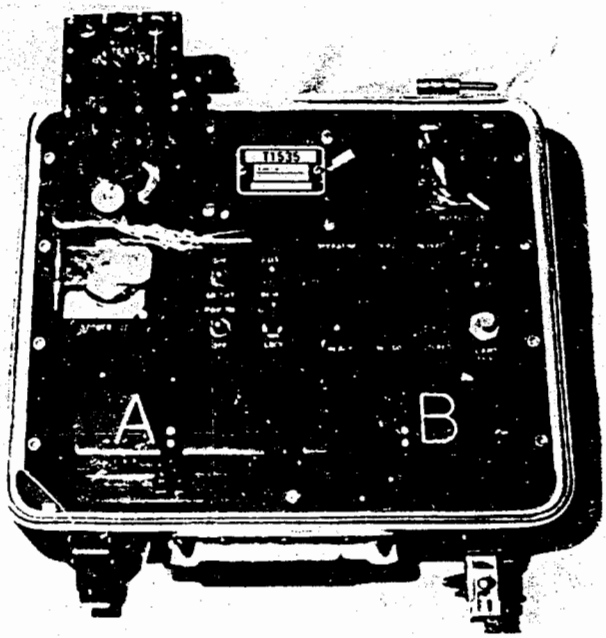

Figure 28. T1535 Decoder with T1547 Attached (U)

2.1.2.13 T1549A Air Force/Navy Programmer for PAL Categories B, D, and F (U)

(U) The T1549A performs two functions when connected to the new controllers. It performs a duration and amplitude check on the aircraft and ground controller output data and power circuits for CAT D and F PAL systems; it also functions as a coded switch simulator for CAT B, D, and F PAL systems for training in decoding operations with the T1549A, the aircraft, and T1535 Ground Decoder.

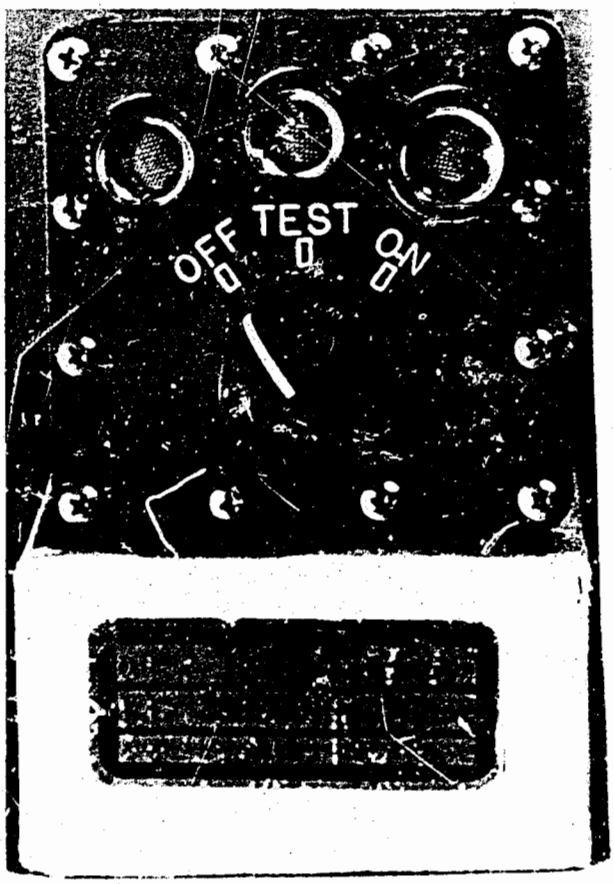

Figure 27. T1547 CAT F PAL Adapter (U)

(U) The T1549A furnishes feedback to the decoder which allows the operator to determine that an acceptable or unacceptable response has occurred. For training operations, storage of seven different codes is provided; any of these codes furnishes "off" and/or lock and unlock indications, as appropriate. The T1549A contains no control switches or monitor lamps. These responses are furnished by the controller to which the T1549A is interfaced.

Three cables are required for use with the T1549A. The CT1504 connects the T1535 Ground Decoder to the T1549A Programmer. This cable is currently used with all Air Force/Navy ground controllers. In addition, the CT1507 cable connects the T1549A to the pylon of the F4C, D, or E, and the CT1510 connects the T1549A to the F-111E aircraft pylon. No external or auxiliary power cable is required because the T1549A is powered by the ground decoder or aircraft safe power.

2.1.2.14 T1554 Army/Navy Decoder for PAL Categories D and F (U)

(U) The T1554 (Figure 29) is a controller used by the Army to lock or unlock the coded switch or to check the locked/unlocked status of the weapon. It is very similar to the T1533 except that it cannot be used to operate the single code CAT C System.

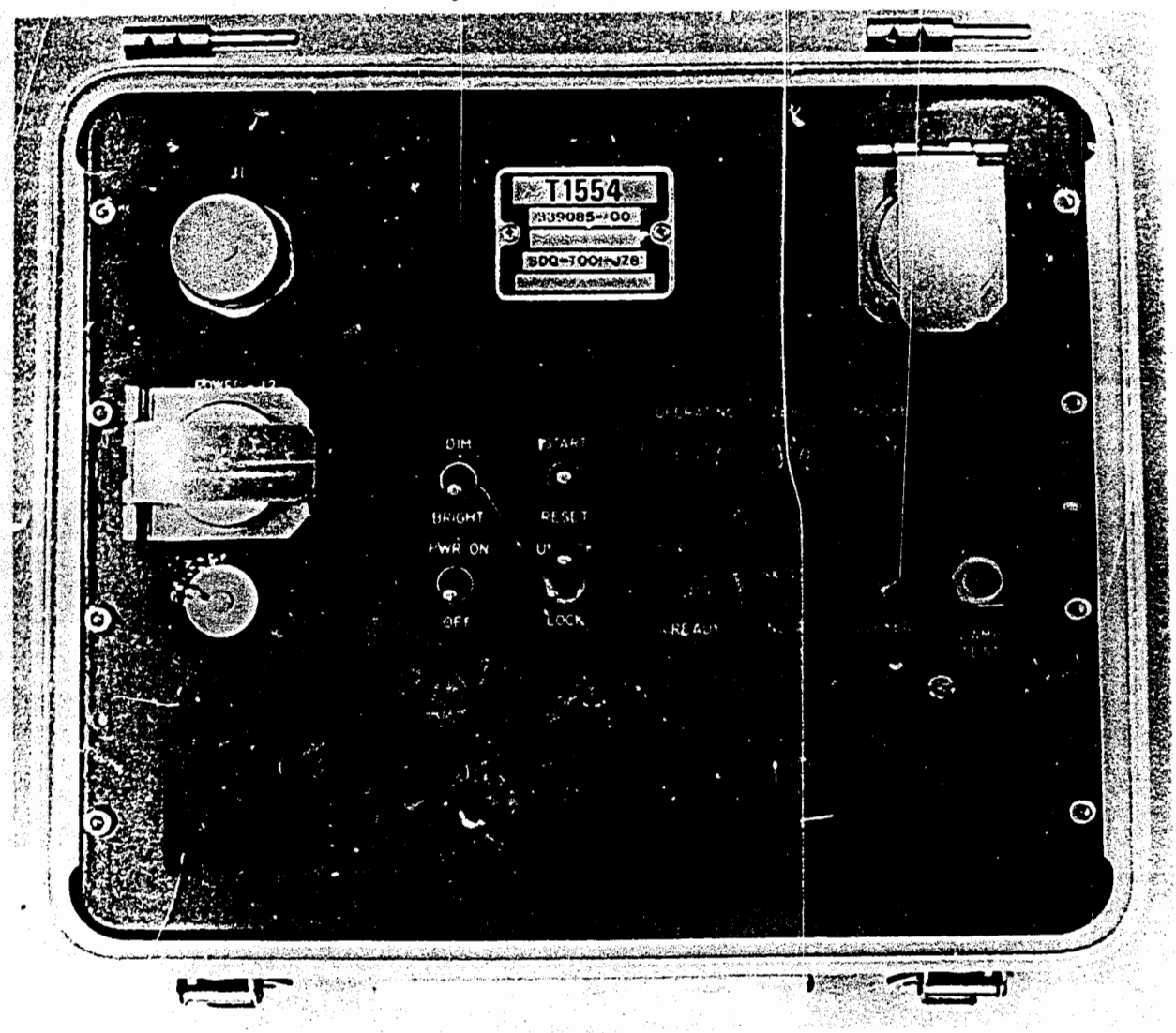

Figure 29. T1554 Army Decoder for CAT D and F PALs (U)

(U) The T1554 is not capable of a recoding operation. Power is supplied through the CT1478 cable from a T436B Power Supply or from a tactical vehicle's battery. If tactical vehicle power is used, the T1554 will operate with the vehicle either off or operating. The decoder was originally purchased to support the W79 system.

2.1.2.15 T1555 Army/Air Force/Navy Recoder/Verifier for PAL Categories B, C, D, and F (U)

(U) The T1555 (Figure 30) is a controller that can be used by all services as either a recoder or a code verifier. The T1555 by itself is a controller used in the field to verify the code values in the coded switch in CAT B, C, D, and F weapons and may also be used to check the locked/unlocked status of the weapon. With the T1558 plug adapter installed, the T1555 is a recoder used in the field to recode and code-check the coded switch in a weapon; it may also be used to check the lock/unlock status of the weapon. A single-code or all-codes recode operation will always leave the weapon coded switch in the locked state. A code-check operation will not change the locked/unlocked status of the coded switch. The T1555 automatically recognizes a coded switch system as either single code or multiple code and furnishes the appropriate signals to the coded switch in a weapon. Power is supplied to the T1555 through a CT1478 cable from the T436B Power Supply. All of the necessary codes (one old and six new PAL codes) plus one new maintenance code are manually set into the T1555. After the codes are set, recoding or code-check is a single-cycle, semiautomatic operation.

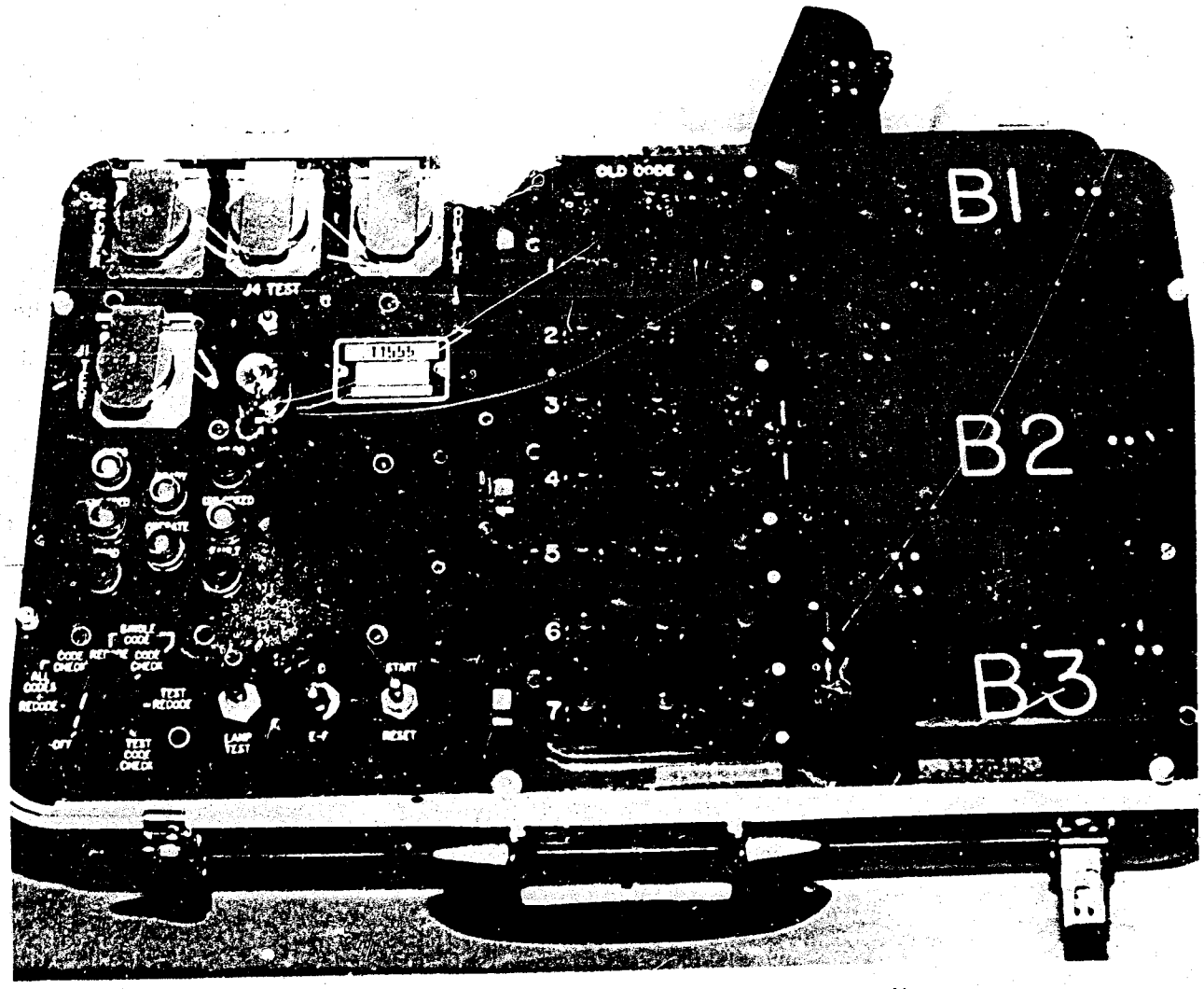

Figure 30. T1555 Recoder/Verifier for CAT B, C, D, and F PALs for Army/Navy/Airforce (U)

2.2.1.6.2 PAL Release Procedures in the European Theater (U)

(U) Weapon Deployment in the European Theater—In general terms, the mission of all US and Allied forces and weapons in Europe is to

> (U) "deter war by their presence and the credibility of their probable use and effectiveness in any conflict situation between Warsaw Pact and NATO forces"[30]

(U) To this end, US nuclear weapons have been deployed to locations in EUCOM for possible use by US and NATO forces. This deployment is made possible through bilateral programs of cooperation negotiated between the host NATO countries and the US.

[redacted]

(U) As weapon and control hardware evolve, improvements and changes are expected to occur. Because a mix of old and new systems is likely to remain, it may not be possible to utilize some capabilities fully. Study of goals and requirements is warranted to give direction to acquisition of future systems.

4. PAL Advanced Development (U)

(U) Today's PAL hardware elements and code management system were described in Section 2. New concepts in both hardware and code management are now in various stages of development. These concepts are summarized in this section.

4.1 New PAL Weapon Systems (U)

(U) The W84 warhead for the GLCM, which is scheduled for deployment in late 1983, is the most recent PAL weapon system described in Section 2. Several other new systems are in various stages of development or production.

(U) The W79 8-in. AFAP preceded the W84, entering Phase 6 production in September 1981. Ultimately the W79 will replace the W33 8-in. projectile in stockpile. However, a date for overseas deployment is uncertain at this time. The W79 is equipped with the MC2907 MCCS that provides CAT D PAL protection.

(C) The W85 PII warhead begins Phase 6 production in May 1983. Eventually, the improved PII system will replace many PIs presently deployed to NATO. The W85 is basically a B61-4, CAT F warhead adapted to the warhead section of the PII missile. As such, it is equipped with an MC2907A MCCS.

(C) The W82 155-mm AFAP that will replace the W48 projectile is presently scheduled to enter Phase 6 production in June 1986. No deployment date has been announced. The W82 will be equipped with the MC3764 CAP (Section 4.2). The CAP will provide the same multiple code population and limited-try features as the MCCS, but the W82 will not be maintained in a disenabled state by interrupting warhead circuitry. Instead, the CAP will be located outside the weapon in a Use Denial Lock (UDL). The UDL (Figure 44) is a device which fastens to the nose of the projectile, preventing installation of the fuze. Unlocking the CAP allows removal of the UDL. An Integrated Control Unit (ICU) in the shipping container of each round will provide unlock and relock control of the UDL (Figure 45).

(U) A factory-rebuild program is currently under way to upgrade early versions of the B61. The B61-6 will result from retrofitting the B61-0 with enhanced safety features and the MC2907 CAT D PAL. First Phase 6 production is scheduled for October 1985. The B61-8 represents a safety upgrade of the B61-2 and B61-5. The B61-8 will have an MC2907 CAT D PAL and is scheduled for initial Phase 6 production in January 1988.

(U) Four strategic systems with PAL are planned for the stockpile. Two of these are modifications of existing systems. The B28 (Mods 0 and 1) will be field retrofitted (beginning April 1983); B61-1 will be factory rebuilt (Phase 6 begins September 1985) into the B61-7. Present plans call for an MC2907 CAT D PAL in both systems. Two new strategic systems, the W80-1 warhead for the Air-Launched Cruise Missile (ALCM) (Phase 6 production began February 1982) and the B83 modern strategic bomb (Phase 6 production is scheduled to begin September 1983), also will be equipped with the MC2907 CAT D PAL.

(U) Two new PAL-equipped Navy systems are currently planned. Both the W80-0 warhead for the Tomahawk Sea-Launched Cruise Missile (SLCM) (Phase 6 production is to begin April 1984) and the W81 warhead for the SM-2 fleet air defense missile (Phase 6 production to begin November 1986) will have CAT D PAL (MC2907 or MC3764).

(U) A stockpile projection[31] (Figure 46) shows the planned distribution of PAL-equipped weapons (weapons with no PAL are not shown) through FY 1992. This projection reflects the planned production of weapons equipped with modern CAT D and F PAL devices.

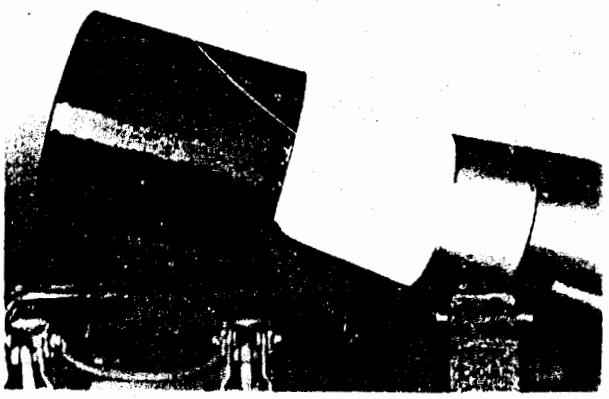

Figure 44. Use Denial Lock (U)

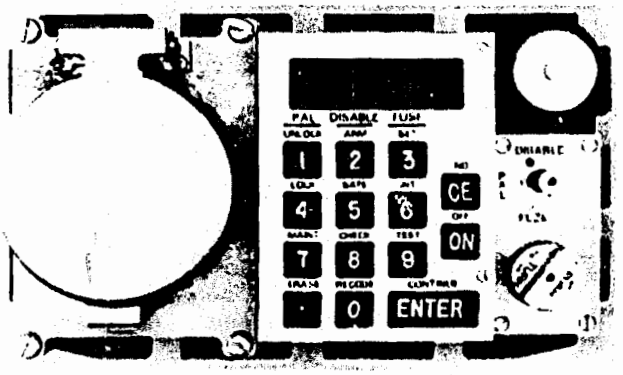

Figure 45. Integrated Control Unit (U)

(U) The HCP (Figure 47) is built around an HP 1000 computer. The system includes a printer, CRT display screen, keyboard, tape and disc storage units, and a cryptographic system. HCP operation is depicted in Figure 48. It has a number of functions. First, it provides access, under two-man control, to encrypted code information from the source data module generated by NSA. In addition, it contains a weapon data base that may be periodically updated.

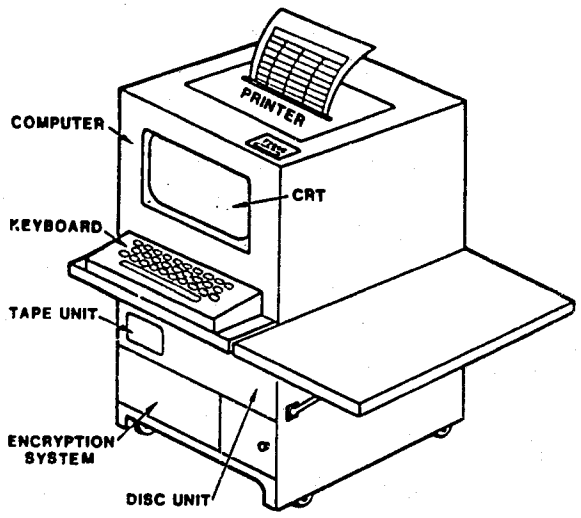

Figure 47. T1565 HQ Code Processor (U)

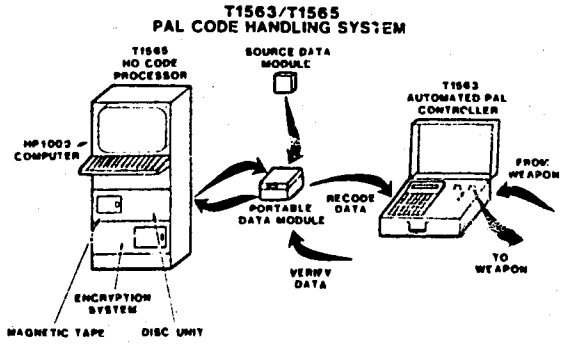

Figure 48. T1563/T1565 PAL Code Handling System (U)

This data base would include, for example, the theater weapon inventory information: mark and mod, serial number, and location of weapons in theater. Utility programs will be available for correlating the data base information with the weapon code information to aid in the construction of theater code plans. Given a theater code plan, the HCP will be able to generate the appropriate portable data modules for use by APCs during recode operations. The HCP will also be capable of reading monitor modules generated by the APC during recode. This may eliminate the need for on-site recode verification by the PMCT in cases where recode can be done with the APC.

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THE WHITE HOUSE
WASHINGTON

June 6, 1962

NATIONAL SECURITY ACTION MEMORANDUM NO. 160

TO: The Secretary of State
The Secretary of Defense
The Chairman, Atomic Energy Commission
The Director, Bureau of the Budget

SUBJECT: Permissive Links for Nuclear Weapons in NATO

1. After an examination of the problem of installing permissive links in nuclear weapons dispersed in NATO commands, I have decided we should now make the commitment to procure appropriate devices for all nuclear weapons, now dispersed and to be dispersed to NATO commands, for both non-U.S. and U.S. forces. (See attached memorandum to me from Dr. Wiesner dated May 29. This decision corresponds to Alternative 5 of that memorandum.)

2. This will require a supplementary appropriation for the Atomic Energy Commission budget. The Secretary of Defense, the Chairman, Atomic Energy Commission, and the Director, Bureau of the Budget will work out the details of the budget presentation.

3. At the earliest feasible time, the Secretary of Defense will submit for my approval a schedule for installation of these devices in NATO weapons. In making this schedule, the Secretary should consult with the Secretary of State on the political problems arising from the existence of weapons assigned to U.S. forces and weapons assigned to our Allies.

4. The Chairman, Atomic Energy Commission, in consultation with the Secretary of Defense, will carry out a research program on an urgent basis directed toward an examination of the feasibility and desirability of more advanced permissive link devices with a wider range of capabilities.

/s/ John F. Kennedy

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APPENDIX A

NSAM-160 and Wiesner Memorandum
Original Document Secret

MEMORANDUM FOR

THE PRESIDENT

At your request, I have reviewed, in consultation with the AEC and the DOD, the technical and cost aspects of equipping nuclear weapons dispersed overseas with permissive link hardware. The object of this review was to establish the program options that were technically available to implement such a program as rapidly as possible, and to determine the amount of supplemental funds that would have to be requested in the AEC FY '63 Budget to accomplish these options.

A decision on this problem involves the following basic policy issues which, while not technical in themselves, are affected by the availability of equipment and the program timing and cost:

(1) Should a permissive link be incorporated at this time in all dispersed nuclear weapons or just in those critical weapon systems with quick reaction, high yield and long range (e.g., Jupiter missiles and quick reaction aircraft)?

(2) Should a permissive link be incorporated at this time in all weapons dispersed to NATO (U.S. as well as non-U.S.) or just to non-U.S. weapons?

(3) Should a permissive link be incorporated at this time in weapons committed to NATO but based in the U.K. as well as weapons based on the European Continent?

These policy issues raised the more basic question as to what objective one is attempting to accomplish by incorporating a permissive link. A permissive link can attempt to meet any of the following objectives, each of which imposes increasingly difficult technical problems:

purpose of this review, I have not attempted to meet a specific objective but rather have analyzed the operational value of the best available equipment and attempted to determine how rapidly it could be incorporated in dispersed nuclear weapons.

While the permissive link equipment presently recommended by the AEC leaves something to be desired and can clearly be much improved with time, I believe that this equipment can be used as the basis for a crash program since development quality hardware exists and initial production and installation could begin in the immediate future.

Specifically the AEC recommends that, if a permissive link program is undertaken on a crash basis, bombs for aircraft and warheads for longer range missiles be equipped with an electro-mechanical lock which would have to receive a prearm numerical code in order to make the weapon operable. In the case of certain bombs which cannot be easily retrofitted with this equipment, as an interim measure pending the development of improved compatible permissive link hardware, mechanical combination locks would be installed to cover a socket into which an arming plug must be inserted. In the case of those bombs as well as short range missiles, such as Honest John and Mike Hercules, and the 8-inch shell, the arming plugs would be stored in self-destruct safes. The proposed program does not include specific hardware for the Davy Crockett missile which presents a particularly difficult problem because of its small size and possible forward deployment.

The numbers which would operate both the electro-mechanical and the combination lock could be held at any echelon or command. If circumstances required, the combination could be held by the U.S. custodial officer himself. This procedure could therefore give the weapons the same state of readiness that they now possess.

In evaluating the utility of this equipment, it must be recognized that it is simply intended to buy time. A specialist with proper equipment might be able to crack the electro-mechanical lock in a few hours time. If he were able to circumvent the self-destruct feature of a safe, a skilled locksmith could open a combination lock relatively quickly. In any event, it would also be possible for skilled technicians familiar with weapons to make these weapons operate in a period of from several hours to weeks, depending on the extent of thier knowledge, by opening the weapons and bypassing the electric circuits. Despite the limitations of this equipment, I believe it would give further (and probably decisive) protection against individual psychotics and would certainly cover unauthorized use by military forces holding the weapons during periods of high tension or military combat. While it would not assure that the weapons could not be used if they were forceably seized by an organized group or a foreign power with technically capable individuals, it would provide in the case of the more important weapon systems equipped with electro-mechanical lock a period of time, varying from hours to days, in which decisions could be made as to what our proper response to the seizure should be. The question of the legal and political requirements of control were beyond the scope of my review.

The question has been raised whether the installation of this development quality hardware on a crash basis might reduce the reliability of the nuclear weapons. However, in view of the simple nature of this equipment and the method of installation, I believe that it is now generally agreed that it would not reduce the inherent reliability of the weapons. The weapons would, of course, not be operable if the combination number were not received from a higher headquarters. This is a communication and management problem, which can be very simple or a very complex, depending on the level of command at which the combination number is held and the degree of control maintained through coding procedures or the use of different combination numbers for different weapons. In its simplest form, it should be possible to handle this procedure wherever a "go code" can be transmitted which is presently a requirement if any control is to exist. In any event, I wish to emphasize that, if circumstances demand, a decision can be made to release the combination number to the U.S. custodian with the field unit and thereby revert to the state of readiness and control that exists today.

At my request, the AEC has estimated the cost and time for completion of the following five alternative programs, which I believe represent the full range of possible application of the permissive link on a crash basis to nuclear weapons dispersed to the European Theater:

The estimated completion date, total cost, and FY '63 for each of these programs is as follows:

Alternative	Estimated Date Completed Installation	Total Cost ($ Millions)	FY '63 Cost ($ Millions)
I	June 1963	3.2	3.2
II	Oct. 1963	11.3	10.6
III	Dec. 1963	13.6	11.7
IV	Mar. 1964	18.6	13.8
V	Aug. 1964	26.9	14.0

A supplemental to the AEC FY '63 Budget would call for obligation of the total cost of the program but expenditure of only the FY '63 cost of the program.

On the basis of this review, I have concluded that it is technically possible to equip on a crash basis all nuclear-weapons dispersed to the European Theater with reasonably effective permissive link equipment at relatively small cost. Therefore, the decision as to the extent to which permissive link equipment should in fact be incorporated in dispersed weapons can be made solely in terms of broad policy considerations as to the desired objective.

Whatever decision is made on the crash program to install permissive link equipment on dispersed nuclear weapons equipment, I would recommend that a vigorous program be undertaken to develop an improved electronic lock which would be incorporated directly in the electronic package associated with all future weapons so that the option of a permissive link would always exist. This program should also include work to develop improved devices to retrofit the bombs and medium range missiles which were equipped with combination locks only as an interim measure in the above crash program. I would also recommend that there be an agressive research program to develop more advanced concepts of the permissive link including mechanics to assure the self-destruction of a weapon if efforts were made to by-pass the permissive link. It is my understanding that the AEC has funds available to cover the R&D necessary for these advanced programs.

Jerome B. Wiesner

APPENDIX B

General Characteristics for PAL Devices
Original Document Secret

Item I

GENERAL CHARACTERISTICS FOR PREMISSIVE DEVICES
FOR USE WITH NUCLEAR WEAPONS (U)

General Characteristics
Approved by the OSD:
13 September 1962

1. Purpose. These General Characteristics define an arming control device for use with designated nuclear weapons which is intended to provide some additional physical means for preventing unauthorized use of nuclear weapons.

2. General Characteristics. The device shall conform to the general characteristics and provide the capabilities listed below:

a. The device shall be capable of repeated enabling, disenabling, and recoding. Further, the device shall be capable of being maintained in either the enabled or disenabled mode.

b. When the device is enabled, a positive indication of enabled condition shall be provided. It is highly desirable that this indication provide no usable information to an unauthorized operator.

c. The time required for authorized enabling of the device shall not add to the weapon system reaction time under any readiness condition. Capability for inflight operation of this device is required for certain aircraft applications.

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e. The device and associated equipment shall be designed so that inspection or disassembly of the weapon will not disclose the combination or code.

f. The combination or code shall be transmitable by all standard communications means, and shall be capable of being changed rapidly and accurately by persons having the appropriate equipment and the old combination or code.

g. The device shall be so located and shall function in such a manner that it will permit performance of the required weapon maintenance, retrofit, and test operation throughout the stockpile-to-target sequence, without enabling the device.

h. The device and associated equipment shall be of such quality as not to decrease significantly the weapon reliability.

i. The device and its associated equipment shall be designed so as to permit installation and use of the device in bombs or warheads without degrading weapon safety.

j. The device installed in the weapon itself should not degrade the delivery capability or alter the ballistics of the weapon system.

k. Meters, dials, and switches on device components which are used in the open without blackout protection shall be illuminated in such a manner that blackout will not be violated.

l. The device and its related equipment shall withstand, without functional impairment or reduction of operational reliability, the environmental criteria specified in the applicable stockpile-to-target sequence of authorized weapon applications and in assoicated environmental specifications.

5. Inspection & Maintenance.

a. The system shall be designed so that inspection or disassembly of any component external to the warhead will not disclose the codes.

b. The permissive action link shall be so located and the system shall function in such a manner that it will permit perormance of the required warhead maintenance, retrofit (including internal and external components exclusive of the permissive action link system), and test operations throughout the STS without changing the mode of the device.

c. The system shall be capable of having maintenance performed on it in either the enabled (unlocked) or disenabled (locked) mode.

d. The operational storage life of that portion of the system installed in the warhead shall be no less than that of other warhead components.

6. Control Equipment.

a. Control equipment with the exception of decoders installed in aircraft shall be designed to permit disenabling (locking) and enabling (unlocking) using the "two-man" concept, and recoding using the "two-team" concept.

b. Control equipment shall provide a positive indication of the mode of the permissive action link device. This indication should provide no information regarding the set code.

c. Decoders shall be capable of enabling (unlocking), disenabling (locking), and code checking.

d. Recoders shall be capable of recoding and code checking the system without enabling (unlocking) the device.

e. Design alternatives which combine decoders and recoders are acceptable.

7. Environmental Considerations.

a. Meters, dials, and switches on componenets which are used in the open without blackout protection shall be illuminated in such a manner that blackout will not be violated.

b. The system and its related equipment shall withstand, without functional impairment or reduction of operational reliability, the evironmental criteria specified in the applicable stockpile-to-target sequence of authorized weapon applications and in associated environmental specifications.

Item 3

GENERAL CHARACTERISTICS FOR
PERMISSIVE ACTION LINK SYSTEMS USED WITH NUCLEAR WEAPONS (U)
(Attachment to DDR&E Letter to Chmn, AEC, same subject, 31 Dec 1970.)
(Original Document Secret)

1. Purpose. To provide general characteristics for permissive action links incorporated in weapon systems to prevent an unauthorized nuclear detonation. This document is not intended to inhibit in any way development of improvements beyond the characteristics set forth.

2. General.

[redacted] DoE b(3)

b. The system shall provide for two modes, unlock and lock of the warhead by insertion of one 6-digit decimal code.

[redacted] DoE b(3)

d. The system shall not significantly degrade weapon reliability, nor shall it degrade safety, or delivery capability. The time required for unlocking the device shall not unduly add to the weapon system reaction time under any readiness condition.

3. System Operation.

a. The control equipment must provide visual indications of the status of the system. As a minimum, the equipment must indicate when (a) the number of unsuccessful unlocking attempts is zero, (b) the number of unsuccessful unlocking attempts is greater than zero but less than that required for lockout, and (c) the device is locked out.

b. The system shall be capable of recoding, unlocking or locking at any point in the STS:

(1) in the case of aircraft weapon systems, up to the time of taxi and/or aircraft launch; and enabling (unlocking) or disenabling (locking) after aircraft launch.

(2) in the case of projectiles, at any time up to the time of loading into the weapon breech.

(3) in the case of missile systems, up to the time of final prefire operations.

c. The code shall be capable of being changed rapidly and accurately by persons using the appropriate equipment. Changing of the code will be dependent upon possession of the old (existing) code.

d. At anytime prior to permanent lockout the feature which counts the number of incorrect tries shall reset to zero whenever the proper code is inserted.

e. The system shall be capable of a code check operation which will allow verification of the set code without changing the mode of the device.

4. System Compatibility and Reliability.

a. The system shall be compatible with the weapon operational concepts to include the readiness requirements stated in the STS.

b. The system will be compatible with normal logistical movement in either selected mode.

c. The system shall be electrically compatible with other weapons system circuitry. In the case of aircraft systems it will be compatible with aircraft circuitry during all phases of circuit operation, both ground and air.

d. The design of control equipment shall preclude permanent locking if a permissive action link operation is interrupted by power failure.

e. The system shall incorporate a means of determining electrically, by a T-304 or similar service continuity test equipment, whether the permissive action link device in the unlocked condition.

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Item 4

GENERAL CHARACTERISTICS FOR
PERMISSIVE ACTION LINK SYSTEMS USED WITH NUCLEAR WEAPONS
(Attachment to DDR&F Letter to Chun, AEC, Same Subject, 26 July 1972)
(Original Document Secret)

1. Purpose To provide general characteristics for AEC-produced electromechanical/electronic permissive action link (PAL) systems used with nuclear weapons to prevent an unauthorized nuclear detonation. This document is not intended to inhibit in any way development of improvements beyond the characteristics set forth.

2. Nomemclature

[redacted]

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3. Definitions

Permissive Action Link (PAL) – A family of devices and subsystems designed to reduce the possibility of obtaining a nuclear detonation from a nuclear warhead without the use (insertion) of a controlled numerical code, thus reducing the probability of an unauthorized nuclear detonation.

Passive Protection – Precludes operation of weapon arming circuits.

Active Protection – Senses attempts to gain unauthorized access to weapon arming circuits, with option to respond by initiating weapon disablement.

Mode – Refers to the protected condition (LOCK) or the unprotected condition (UNLOCK) of the PAL.

State – Refers to the condition of the active protection feature (OFF/TEST/ON).

Unlock Code – A preset code used to unlock the PAL.

Off Code – A preset code used to change state of OFF.

Code Check – Confirms stored code(s) in PAL without affecting weapon PAL mode.

Recode – Allows changing of stored code(s) in PAL.

Code Inhibit – Precludes a second unlock of a PAL with a given code until recode.

Limited-Try – Counts consecutive incorrect code trials and resets to zero on a correct code trial.

Temporary NO-GO – Precludes additional code trial operations without special field equipment after a number of incorrect code trials.

Permanent NO-GO – Precludes additional code trial operations with field equipment after additional incorrect code trials.

4. General Characteristics

A. Category A and Category B [redacted]

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2. These systems shall provide for two modes, UNLOCK and LOCK of the PAL by insertion of one 4-digit decimal code.

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B. Category B'

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3. The system shall provide for two modes, UNLOCK and LOCK of the PAL by the insertion of one 4-digit decimal code.

C. Category C – The characteristics stated above (Category B') apply with the following modifications:

1. The system shall provide for two modes, UNLOCK and LOCK of the PAL by insertion of one 6-digit decimal code.

D. Category D

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C. (U) All Categories

(U) 1. The system shall be compatible with the weapon operational concepts to include the readiness requirements stated in the STS.

(U) 2. The system shall be compatible with normal logistical movement in any selected mode.

(U) 3. The system shall not significantly degrade weapon reliability, safety or delivery capability. The time required for unlocking the device shall not unduly add to the weapon system reaction time under any readiness condition.

(U) 4. The system shall be capable of being recoded, code checked, unlocked or locked at any point in the STS up to:

a. (U) In the case of missile systems, up to the time of final pre-fire operations.

b. (U) In the case of aircraft weapon systems, up to the time of taxi and/or aircraft launch, with unlocking or locking after aircraft launch. However, recode is not required after weapon loading on aircraft.

(U) 5. The system shall contain a Master Recode feature to allow recoding of all stored codes using any one of the old codes which has not been inhibited.

(U) 6. The system shall be capable of being recoded rapidly and accurately by persons using the appropriate equipment.

4. (U) CONTROL EQUIPMENT

A. (U) All Categories

(U) 1. The system shall be electrically and mechanically compatible with the weapon system. In the case of aircraft systems, any equipment installed in the aircraft or associated with the weapon will be compatible with aircraft circuitry during all phases of aircraft operation, both ground and air.

(U) 2. The system shall incorporate a means of determining electrically, by service continuity test equipment, whether the PAL is in the unlocked condition.

(U) 3. The control equipment must indicate when (a) the number of unsuccessful trial attempts is zero; (b) the number unsuccessful code trial attempts is greater than zero but less than that required for NO-GO; and (c) the device is NO-GO.

(U) 4. Control equipment shall be provided that will:

a. (U) Allow recoding and code checking without unlocking the PAL.

b. (U) Allow recoding any one or all unlock and off codes using one not inhibited stored code.

c. (U) Allow code checking all stored codes in one operation or code checking any one of the stored codes.

d. (U) Allow unlocking and locking the PAL.

e. (U) Allow PAL unlocking and locking operations in an aircraft to be performed by a single individual.

(U) 5. New control equipment shall minimize potential TEMPEST, tampering, and bugging vulnerabilities. DoE b(3)

5. (U) INSPECTION AND MAINTENANCE

A. (U) All Categories

(U) 1. The system shall be designed so that inspection or disassembly of any component external to the warhead will not disclose the codes.

(U) 2. The PAL system shall function in such a manner that with the active protection OFF, warhead maintenance and test operations can be performed without changing the mode of the passive protection.

6. (U) ENVIRONMENTAL CONSIDERATIONS

A. (U) All Categories

(U) 1. The system and its related equipment shall withstand, without functional impairment or reduction of operational reliability, the environmental criteria specified in the applicable weapon stockpile-to-target sequence.

(U) 2. Meters, dials, and switches on components which are used in the open without blackout protection shall be illuminated in such a manner that blackout will not be violated.

APPENDIX C

Letter from J. P. Wade, Jr., to D. C. Sewell

UNCLASSIFIED

DEPARTMENT OF DEFENSE
MILITARY LIAISON COMMITTEE
TO THE
DEPARTMENT OF ENERGY
WASHINGTON, D.C. 20301

April 18, 1980

Honorable Duane C. Sewell
Assistant Secretary for
Defense Programs
Department of Energy
Washington, D.C. 20585

Dear Mr. Sewell:

(U) Over the past several months a great deal of concern and discussion has surfaced involving the policy for non-violent disablement and what role it should play in nuclear weapon security matters. Specific controversy has centered on questions of: which weapons should have a disable capability?; what level of sophistication should be credited to the threat?; and how long should disablement render the weapon useless against this threat? Department of Defense guidance to the Department of Energy in this area has been presented in systems Military Characteristics and POG meetings, as well as in the Nuclear Weapon Development Guidance. Unfortunately, in many cases it has been less than specific or subject to interpretation in application.

(U) I would like to clarify the existing situation and toward that goal, two transmittals are enclosed. The first is a DoD statement of policy addressing the goals and current assessment needs associated with nuclear weapon disablement systems. The second is a revision of the July 1972 "General Characteristics for Permissive Action Link Systems Used with Nuclear Weapons."

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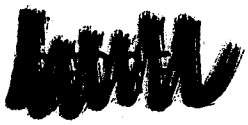

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(U) The paper "General Characteristics for Permissive Action Link Systems Used with Nuclear Weapons" should be viewed as the basic DoD definitions for PAL systems in acquisition of weapon systems incorporating DoE produced PALs. This paper, that supersedes the original 1972 document and amendments, will be forwarded to DNA for handling in a manner similar to weapon military characteristics, that is DNA will be responsible for publication and maintenance of an up-to-date file including amendments that may occur in the future. Consistent with our intention to work toward standardization of PAL devices and associated control equipment, only three PAL systems, Category D, E, and F are addressed in this update of the paper. Earlier PAL devices continue to remain in the stockpile: however, their acquisition cycle has been completed and therefore they have not been included in this update of the characteristics document.

Sincerely,

/s/ James P. Wade, Jr.
Chairman

Attachments
a/s (SFRD)

APPENDIX F

Excerpt From Amendment 3 to the Military Characteristics for a Nuclear Warhead for the 155 mm Howitzer Projectile (Approved by the MLC 27 April, 1971)

3. Control Devices

3.1 Security Container System (SCS)

An SCS, compatible with projectile and warhead designs, will be used with the M517 on an optional basis. The SCS will be developed under a program separate from the XM517 development program. The SCS shall be designed and function as specified in the SCS Characteristics attached as an Appendix.[2]

3.2. Permissive Action Link (PAL)

The PAL shall conform to the general characteristics outlined in the letter from the Director of Defense Research and Engineering to the Chairman of the Atomic Energy Commission, "General Characteristics for Permissive Action Link Systems Used with Nuclear Weapons," dated 31 December 1970.

3.2.1. The PAL control equipment shall also operate and be capable of recoding the SCS six-digit, limited-try coded switch.

3.2.2. It is desired that the control equipment be compatible with Category B, six-digit single code PAL devices.

3.2.3. The system shall provide for two modes, unlock and lock for the warhead by insertion of one six-digit decimal code. Unlock shall occur upon the insertion of any one correct code of six preset unlock codes. These unlock codes may be preset so that each is unique, or so that redundancies occur among them.

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